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Universidad de Almería
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Questionnaires do not discriminate motor imagery ability of people with different motor expertise

Francesco Di Gruttola* and Laura Sebastian*

LA HABILIDAD EN IMAGINACIÓN DEL MOVIMIENTO NO PUEDE DISCRIMINARSE MEDIANTE CUESTIONARIOS ENTRE PERSONAS CON DISTINTAS HABILIDADES MOTORAS

KEYWORDS: Motor imagery; assessment; sport psychology; vividness of movement, imagery questionnaire.

ABSTRACT: Questionnaires are presented as reliable measure of motor imagery (MI), i.e. the ability to mentally simulate a movement in an internal perspective. Although there is some evidence that MI is domain-specific (i.e., i.e., higher scores for motor imagery may be generated by people with extensive real-world experience and practice), MI studies have typically employed fixed and generic movements as items. Thus, we investigated the content validity of the movement items of the Vividness of Movement Imagery Questionnaire–2 (VMIQ-2). Sixty participants were divided in groups of athletes (competitive and not-competitive, with an extensive motor experience) and not-athletes (with a reduced motor experience) and analysed by means of a mixed factorial MANOVA. The three MI modalities, external visual, internal visual and kinesthetic imagery, did not result in significantly different scores between the groups. We recommend caution in using MI generic questionnaires in studies that compare people with different motor experiences. Moreover, we suggest that the structure of the questionnaires should be redesigned, in order to make them adaptable to the specific needs of professionals and researchers.

Motor imagery (MI), i.e. the ability to simulate an action in an internal perspective (Moran, Guillot, Macintyre and Collet, 2012), is commonly measured: (1) subjectively by means of questionnaires based on self-evaluation of imagery skill on a Likert scale (Roberts, Callow, Hardy, Markland and Bringer, 2008; Williams et al., 2012); (2) and objectively by means of chronometry (Collet, Guillot, Lebon, Macintyre and Moran, 2011), comparing the timing of a movement and of its related imagery, with isochrony indicating high imagery skill. These two measures are not redundant and should be used together for a complete MI assessment (Marchesotti, Bassolino, Serino, Bleuler and Blanke, 2016; Williams, Guillot, Rienzo and Cumming, 2015). In this regard, a recent study by Williams et al. (2015) found a dissociation between chronometry and questionnaire scores. In this study, the authors evaluated visual external, visual internal and kinesthetic imagery modalities in athletes with different levels of expertise. They also found that only the subjective measures yielded significant differences in the three MI modalities in the group of elite athletes, which reported higher ratings of kinaesthetic than visual internal and external imagery (Williams et al, 2015). Thus, the authors advanced the hypothesis that 1) the questionnaires could measure the ability of the participant to create a mental image, while 2) the chronometry could measure the ability to control and maintain a mental image in the mind (Williams et al., 2015). A further evidence of the importance of both a subjective and objective assessment was underlined by Marchesotti et al. (2016), who highlighted the importance of measuring MI ability by means of both chronometry and questionnaires in order to discriminate people's high or low aptitude to use a MI-based brain computer interface (BCI) intervention (Marchesotti et al., 2016).

Correspondence: Francesco Di Gruttola, Department of Translational Research and New Technology in Medicine a Surgery, University of Pisa. Via San Zeno, 31, 56127 Pisa (Italy). E-mail: francesco.digruttola@unifi.it
*Department of Translational Research and New Technology in Medicine and Surgery, University of Pisa Grup
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Questionnaires are based on general motor gestures, not linked to a specific sports (Roberts et al., 2008; Williams et al., 2012), which made them usable to evaluate people with different motor experiences. However, MI ability is domain-specific, being higher for peculiar motor gestures of athletes' experience. In fact, neural network involved in MI of specific motor gestures of athlete's experience are different between experts and novices (Wei and Luo, 2010).

In this vein, personalized imagery interventions could be used for improving sport performance, such as the PETTLEP model, by Holmes and Collins (2001). This model is based on the functional equivalence hypothesis (Finke, 1979), stating that during both the execution and the imagery of the same gesture, an increase of task difficulty corresponded to a decrease in its accuracy (Fitts, 1992). The acronym PETTLEP established seven key points that must be met to perform an imagery experience as closely as possible to the related movement (Holmes and Collins, 2001). For instance, the T (Timing) letter suggests to maintain the imagery timing as similar as possible to that of its actual execution; the "L" (Learning) advises to not imagine gestures that the person did not already learn; and, the "P" (Perspective) suggests to plan in advance the modality in which the specific movement should be imagined.

The aim of the present study was to question the content validity of the items of MI questionnaires. In this regard, we investigated in young adults if there were differences in MI vividness between groups of current sport participants (athletes, who had an extensive motor experience) and not participants (not athletes, who had a reduced motor experience). We did not expect significant differences in MI quality (visual external, visual internal and kinesthetic imagery) between the groups of athletes and not athletes. In fact, despite the questionnaires are validated measures of imagery skill they use general motor gestures, not linked to a specific sport as items, while MI is a domain specific ability.

Method

Participants

We recruited 60 young adults, university students (Mage ±*SD* = 24.51 ±4.57 yrs., 30 females) with different levels of sport experience to take part to the experiment at the Sport Psychology lab of the Department. The study was conducted in accordance with the standards of the Declaration of Helsinki (World Medical Association, 2013) with the approval of the local ethics committee (ID 2805). All of them signed the informed consent for psychological research and the privacy form.

The age, gender and sport experience of the participants were recorded. According to their sport level they were classified as competitive athletes (COM - if they competed with opponents with the aim to achieve the best performance), not-competitive athletes (nCOM - if they carried out a regular and weekly physical practice without competition) and not-athletes (nAT - if they did not practice a regular physical activity) (Table 1). We used an "ad hoc" sampling method, asking in advance informations about sex and their sport level, so as to obtain groups with the same sample size and balanced for gender.

We obtained groups with the following characteristics (Table 1): the COM group was composed by athletes (years of sport practice mean ±*SD* = 16.50 ±6.36) who played both individual (46.7%) and team sports (53.3%); the nCOM group was composed by athletes (years of sport practice mean ±*SD* = 15.20 ±7.49) that played more individual (84.6%) than team sports (15.4%); the nAT group was composed by people with a lower past motor experience compared to the other two groups (years of sport practice mean ±*SD* = 8.25 ±4.30).

Instruments

Participants were invited to sit on a chair and were asked to compile the Vividness of Movement Imagery Questionnaire – 2 (VMIQ-2 - Roberts et al., 2008) so as to evaluate their MI quality in terms of vividness.

Procedure

This was a self-assessment questionnaire that measured twelve movements (e.g. run, cycle, throw a stone in the water) in three imagery modalities: external visual imagery (watch yourself perform each movement from the outside) (EVI), internal visual imagery (watch yourself perform each movement from the inside) (IVI) and kinesthetic imagery (feel your body while executing each movement) (KIN). Participants had to imagine the movements with their eyes closed and without actually executing them. After every imagery experience, they had to evaluate the vividness of each image on a Likert scale that ranged from 1 (not image at all) to 5 (image perfectly clear and vivid). The score of each scale was obtained by averaging the ratings to the twelve items.

Data analysis

Data analysis was performed by means of IBM SPSS statistical software (Version 20.0). Firstly, we checked for the presence of outliers in the VMIQ-2 scores within the three groups. No outliers were found. Moreover, in order to use parametric tests we controlled if our data assumed a normal distribution. Skewness and kurtosis of the dependent variables (EVI, IVI and KIN) within the different groups (COM, nCOM and nAT) always showed values between ±2 and the Shapiro-Wilk test was not statistically significant ($p > .05$). Levine's and Box's test of variance and covariance homogeneity, were not statistically significant ($p > .05$). Thus, our data met all the assumptions to perform a multivariate analysis of variance.

Then, we evaluated if the three MI modalities assumed different scores between the three groups by means of a Group (COM, nCOM, nAT) X Imagery Modality (EVI, IVI, KIN) mixed factorial MANOVA .

Significance was set at $p = .05$. We calculated the partial eta squared (η^2_p) as MANOVA effect size measure (Cohen, 1988). We also obtained the statistical power (ε) as the probability to reject the null hypothesis correctly, setting the minimum desired value to .80 (Cohen, 1988).

Results

Means and standard errors scores of the three groups and of the whole sample for the VMIQ-2 are shown in Figure 1 and the results of the statistical analysis are displayed in Table 2.

The mixed factorial MANOVA yielded a significant effect for *Imagery Modality*, F (2, 114) = 9.507, $p = .001$, $\eta^2_p = .143$, ε = .951. Post-hoc comparisons performed with Bonferroni correction of the significance level, showed a significant difference between the EVI modality and both the IVI ($p < .001$) and the KIN ($p < .05$) ones. The EVI mean (M ±SD = 3.24 ±.92) was smaller respectively than IVI (M ±SD = 3.64 ±.82) and KIN (M ±SD = 3.58 ±.82). No significant *Group* nor *Interaction* effects were found ($p > .05$).

Discussion

The aim of our investigation was to explore the content validity of the items of a subjective measure (questionnaire) to distinguish MI quality between athletes (competitive and not competitive) and not athletes. Results did not reveal significant differences in MI abilities between groups but only a general difference in the whole sample between two different motor imagery perspectives: (1) an internal (IVI and KIN), that is, imagine to see/feel themselves in a first person; (2) and an external (EVI), that is, imagine to see themselves from a third person (Moran et al., 2012). Thus, our results support the findings that MI is a domain-specific skill. In fact, comparing groups of athletes with an extensive motor experience that were involved in different sports with not-athletes, did not yield significant differences in MI quality. These results were in line with what is well-established in literature. For instance, Wei and Luo (2009) compared brain activations of professional drivers and normal people during kinesthetic imagery of both simple and professional motor skills by means of fMRI. During the imagery of the simple motor skills there were not differences between the two groups. Conversely, the drivers revealed an experience-related activation located in the parahippocampus during the imagery of the professional skills compared to the novices. This reflected a better use of kinesthetic imagery in the drivers compared to the novices only for specific motor gestures of their experience. Consequently, the use of questionnaires as an “unconditioned” method to measure MI ability may be misleading. The VMIQ-2, as well as another instrument like the Movement Imagery Questionnaire -3 (Williams et al., 2012), uses general motor gestures to assess MI ability. In this regard, we advise against the use of such instruments in studies aimed to discriminate MI ability between people with different motor experiences. Researchers should develop a motor imagery questionnaire more adaptable to specific activities and sports, without fixed items. We therefore propose to redesign the structure of these instruments to obtain a new tool that allow to personalize the items according to the specific needs of practitioners and researchers. For example, the PETTLEP model by Holmes and Collins (2001) cited in the introduction could be used for the purpose. This scenario would integrate theoretical and practical aspects, delivering not only a new and effective tool but also a meeting point between research and professional practice.

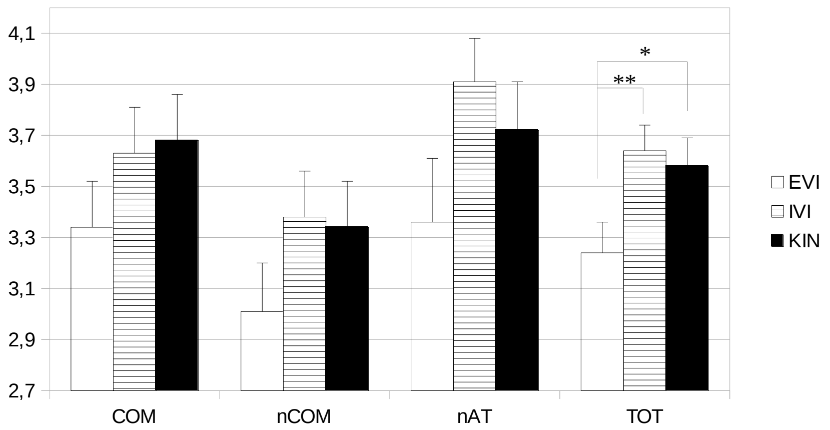
	%			Means (SD)				
	Males	Ind. sp.	Team sp.	Yrs. sp. Prac	Age	EVI	IVI	KIN
COM	50%	46.7%	53.3%	16.50 (6.36)	25.37 (4.34)	3.34 (.79)	3.63 (.81)	3.68 (.81)
nCOM	50%	84.6%	15.4%	15.20 (7.49)	25.65 (3.25)	3.01 (.83)	3.38 (.82)	3.34 (.79)
nAT	50%	-	-	8.25 (4.30)	22.55 (5.41)	3.36 (1.11)	3.91 (.77)	3.72 (.86)
TOT	50%	-	-	13,32 (7.10)	24.51 (4.57)	3.24 (.92)	3.64 (.82)	3.58 (.82)

Notes: COM = competitive athletes, nCOM = not competitive athletes, nAT = not athletes, TOT = whole sample, Ind. sp. = individual sports participants, Team sp. = team sport participants, Yrs. sp. Prac. = years of sport practice, EVI = external visual imagery, IVI = internal visual imagery, KIN = kinesthetic imagery.

Table 1. Descriptive informations and mean and SD of the Vividness of Movement Imagery Questionnaire –2 (VMIQ-2) scales in the three groups of actual motor practice and in the whole sample.

	Group X Imagery Modality	Imagery Modality
F	0,356	9,507
p value	.796	.001
η^2_p	.012	.143
ε	.119	.951

Table 2. Statistical output of the Group (competitive athletes, not-competitive athletes and not-athletes) X Imagery Modality (external visual, internal visual and kinesthetic imagery) mixed factorial MANOVA.



*** p < .001; * p < .05*

Notes: COM = competitive athletes, nCOM = not competitive athletes, nAT = not athletes, TOT = whole sample, EVI = external visual imagery, IVI = internal visual imagery, KIN = kinesthetic imagery.

Figure 1. Vividness of Movement Imagery Questionnaire-2 (VMIQ-2) means and standard errors of external visual, internal visual and kinesthetic imagery scores in groups of athletes (competitive and not-competitive), not-athletes and in the whole sample.

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PALABRAS CLAVE: Capacidad de imaginación motora, evaluación, psicología del deporte, vivacidad del movimiento, cuestionario de imágenes.

RESUMEN: Los cuestionarios han sido considerados como medidas fiables y válidas de imaginación motora (IM), entendida como la habilidad de un sujeto de simular mentalmente un movimiento desde su perspectiva interna. Aunque hay evidencia que la IM es específica de dominio (e.g. puntuaciones más altas de IM se generan en aquello sujetos con mayor práctica y experiencia en el mundo real). En este estudio, hemos investigado la validez de contenido para los items de movimientos de la escala VMIQ-2 ("Vividness of Movement Imagery Questionnaire–2"). Sesenta participantes fueron divididos en 2 grupos mediante MANOVA factorial mixto: un grupo de "atletas" (con mayor experiencia motora, participación competitiva y no competitiva) y un grupo de "no-atletas" (con una experiencia motora reducida). Como esperábamos, los grupos no difirieron en ninguna de las puntuaciones de las tres modalidades de la IM (visual externa, visual interna y cinestésico). Por ello, recomendamos ser cuidadosos en la utilización e interpretación de los cuestionarios de IM en estudios que comparan personas con distintas habilidades motoras. Además, la estructura de los cuestionarios probablemente deba volve a diseñarse para hacerlos adaptables a las necesidades específicas de los profesionales e investigadores

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